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GAIN IN WEIGHT AND THE CHILD'S PHYSICAL FITNESS*

By RACHEL M. JENSS
Washington, D. C.

GAIN in weight is coming more and more into use as one index of the physical fitness of children. As long ago as 1922, Holt (5) recommended its use. More recently, the Chief Medical Officer of the Board of Education of Great Britain (4), Daley (1), Frank (2), Friend (3), Kershaw (6), Nyswander (7), Turner (8), Wilkins (9), and others have pointed out the advantages of such a dynamic, as contrasted with a static, measure of the child's condition.

In the present investigation [1] an effort has been made to evaluate

* Grateful acknowledgment is made to Dr. Martha M. Eliot, Associate Chief of the Children's Bureau, U. S. Department of Labor, and other members of the staff, for their constructive criticisms of this report.

[1] This investigation was based on data regarding 301 selected children who had been weighed at stated intervals during a period extending over 2 school years (1934-35 and 1935-36) in the course of a study of the physical fitness of 713 New Haven school children, made by the Children's Bureau of the U. S. Department of Labor with the cooperation of the Institute of Human Relations of Yale University and the Department of Pediatrics of the Yale University School of Medicine. Dr. Susan P. Souther, now Director of the Bureau of Child Hygiene, Ohio State Department of Health, and formerly on the staff of the Children's Bureau supervised the field work and made all the physical examinations of the children. A report of the larger study was issued as Children's Bureau Publication No. 263. (Jenss, Rachel M., and Souther, Susan P.: Methods of Assessing the Physical Fitness of Children. 121 pp. *Washington*, 1940.) The data have been used in this report with the permission of the Children's Bureau.

gain in weight as an index of the physical fitness[2] of children, using as a criterion two types of observations made on each of 301 children observed during a period of 19 or 20 months: First, a pediatrician's assessment of the child's general nutritional status, and secondly, a very rough index of the adequacy of the child's diet; namely, the number of cups of milk he consumed per day.

MATERIAL AND METHOD OF STUDY

Individual study was made of the gain in weight of 301 children, all of the same race and nationality, all living in the same city, all of fairly definite ancestry.[3] All the children were of approximately the same age at the initial weighing; all the initial weighings were made on approximately the same date; all the children were weighed at stated intervals over a considerable period of time. The control of these factors made it possible to obtain comparable estimates of the gain in weight of all the children included in the study.

Each estimate is expressed in percentage form and thus evaluates the child's gain in weight in relation to his attained weight at the beginning of the period during which the gain took place.

As each child studied was in sufficiently good health to be in school throughout the major part of two school years, it is obvious that the children included in this study were more physically fit than an unselected group of school children and that their gain in weight represents that of a relatively healthy group.

Selection of the children

Selection of the children upon the basis described in the preceding section[4] was done so as to obtain a homogeneous group of the

[2] For a discussion of the term physical fitness see pp. 1-2 of the report cited in footnote 1.

[3] As the number of children studied was small, with the two sexes about equally represented (153 boys and 148 girls), and as the frequency distributions of the gain in weight of the boys were not significantly different from the corresponding distributions for the girls, the findings are presented for the total number of children only. Since, however, the means and medians of the distributions for the boys tended to be smaller than the corresponding averages for the girls, the analyses were made not only for the total but also for each sex. With a few minor exceptions, the findings for each sex confirm the findings for the total.

[4] The fact that all the children were single-born and were of legitimate birth, introduced additional selective factors besides those set by the conditions of this study.

following description:

1. Each child was white.
2. Each was born in the United States.
3. Each lived in New Haven, Conn., throughout the period of observation.
4. Each lived in his own home or in a foster home.
5. Each was of ancestry that could be identified as Italian; practically all the children had all four grandparents born in Italy.[5]
6. The age of each child at the time of the initial weighing was within 3 months of his sixth birthday; that is, the child was at least 5 years 9 months of age, but had not reached the age of 6 years 3 months.
7. The initial weighing of each child was done during the 4-day period, September 24-27, 1934.
8. Each child had been weighed at least seven times at stated intervals during a period of 19 or 20 months.

Clinical assessment of general nutritional status

The children were divided into three broad general nutritional-status groups: (1) "Excellent or good," (2) "Borderline," (3) "Poor or very poor." These groups were derived from an original classification based on a five-point scale of general nutritional status, used by the pediatrician[6] in assessing the children's condition toward the end of the period of observation.[7] The assessment had been based primarly on color of mucous membranes, quality of muscle, and amount of fat. Other items, including posture, condition of the skin and hair, and general development, were also given consideration in arriving at a final assessment.[8] Gain in weight was not taken into account.

[5] The limitations of this definition are discussed in a paper by Rachel M. Jenss, entitled "Gain in weight and its association with ancestry and economic status," which appeared in HUMAN BIOLOGY, vol. 12, pp. 532-544 (December, 1940).

[6] The pediatrician who made all these physcial examinations was exceptionally well trained and had had considerable experience examining school children, particularly boys and girls living in New Haven. Her assessment was found to be sufficiently stable and objective to permit classification of the children into the three broad general nutritional-status groups used in this study. See in this connection pp. 82 ff. of the report cited in footnote 1.

[7] The physical examination on which the assessment was based had been given the child at approximately the age of 7 years 3 months (about 5 months before the end of the observation period).

[8] The procedure used in assessing the child's condition is described on pp. 42 ff. of the report cited in footnote 1.

Adequacy of diet

At about the time the clinical assessments were made, information on each child's dietary habits had been obtained at an interview with the mother or other member of the family. This information included the average number of cups of milk the child consumed daily during the week preceding the interview.

It is well known that a diet including sufficient milk is adequate with respect to several essential nutrients that are almost impossible to obtain in sufficient quantities from a diet low in milk. Therefore, it may be assumed that a child's diet including the amount of milk recommended for children of his age is better in general than a diet that includes considerably less than the amount recommended. On this assumption a very rough definition of adequacy of diet was set up, based on the Children's Bureau recommendation that a child of this age needs 1½ pints to a quart of milk daily.[9] As the ordinary household cup holds less than half a pint, and as it is unlikely that the cups of milk given to the children were filled to the brim, it was considered that a reported average of "less than 4 cups" meant that the child was probably getting less than the 1½ pints recommended as a minimum by the Children's Bureau. For this reason, "less than 4 cups" of milk a day was considered to be indicative of an inadequate diet, and "4 cups or more," of a more nearly adequate one.

Combination of two types of observations as an approximate criterion of physical fitness: clinical assessment of general nutritional status and adequacy of milk consumption (as an indication of adequacy of diet)

Clinical assessment of children's general nutritional status is recognized as an index of their physical fitness. It is not an exact measure. (In fact, there is no such measure.) It was, therefore, considered advantageous in this study to differentiate further between the children in each nutritional-status group according to still another index of physical fitness: adequacy of milk consumption, as an indication of adequacy of diet.

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[9] U. S. Department of Labor, Children's Bureau: The Road to Good Nutrition by Lydia J. Roberts, p. 13. *Washington*, 1942.

If children in a given nutritional-status group are classified according to the adequacy of their diets, it is fair to assume that their physical fitness can be more satisfactorily assessed on the average than if they are not so classified, as both clinical assessment of general nutritional status and adequacy of diet (indicated in this case by adequacy of milk consumption) are recognized measures of the child's well-being. Therefore, these two factors were selected from among others and used in combination in this study as an approximate criterion for testing the value of gain in weight as an index of physical fitness.

According to this criterion six "physical fitness" groups were established, as follows:

1. "Excellent or good" general nutritional status; adequate milk consumption.
2. "Excellent or good" general nutritional status; inadequate milk consumption.
3. "Borderline" general nutritional status; adequate milk consumption.
4. "Borderline" general nutritional status; inadequate milk consumption.
5. "Poor or very poor" general nutritional status; adequate milk consumption.
6. "Poor or very poor" general nutritional status; inadequate milk consumption.

Method of estimating percentage gain in weight of each child

Examination of the successive weights [10] of each child throughout the period of observation showed that, within the error of measurement, the trend or pattern of his weights was exponential in form; that is, the increase in the child's weight during a given month, expressed as a percentage of his weight at the beginning of the month, was about the same for each month throughout the period of observation (19 or 20 months).

Accordingly, the child's progress in weight may be conveniently described by the equation, $y = ae^{bx}$. In this equation the variable, y, repre-

[10] The weighings were done at school on balance scales, which were checked at frequent intervals. The child was weighed without shoes and without coat or sweater, and the weight was recorded to the nearest quarter of a pound.

sents the child's calculated weight (in pounds) as distinguished from his observed weight; and x, the child's age (in completed months) at the time the weighing was done. The parameter, b, is the only one which has any significance in this study; it measures the child's average percentage gain (or loss) in weight per month during the period of observation; if the child is gaining weight, b is positive, and if the child is losing weight, it is negative. The larger b is, the larger is the child's average percentage gain in weight, regardless of his weight at the beginning of the period of observation.

The equation, $y = ae^{bx}$, described previously, was fitted to the successive weights of each child by the method of least squares. An illustration of this method, as used in calculating the average monthly percentage gain in weight of one of the girls studied is shown in Table I.

TABLE 1

Illustration of method used in calculating the average monthly percentage gain in weight

	AGE (Months)		WEIGHT (Pounds)	LOG y	$(x')^2$	(x')LOG y
	x	x'*	y			
	74.07	14.07	42.50	1.6284	197.9649	22.9116
	75.00	15.00	42.25	1.6258	225.0000	24.3870
	78.10	18.10	45.00	1.6532	327.6100	29.9229
	80.77	20.77	44.75	1.6508	431.3929	34.2871
	82.23	22.23	46.25	1.6651	494.1729	37.0152
	85.80	25.80	47.25	1.6744	665.6400	43.1995
	86.80	26.80	48.00	1.6812	718.2400	45.0562
	89.83	29.83	48.25	1.6835	889.8289	50.2188
	94.00	34.00	51.50	1.7118	1156.0000	58.2012
Totals	.....	206.60	.....	14.9742	5105.8496	345.1995

Normal equations: $14.9742 = 9.\ \log a + 206.60\ b \log e$

$345.1995 = 206.60 \log a + 5105.8496\ b \log e$

Solving: $b = 0.009245$

$a = 37.29$

and $y = 37.29e^{0.009245x'}$

Therefore, during the 20-month period of observation, from 74.1 to 94.0 months of age, this girl's weight increased on the average 0.92 per cent per month.

* An arbitrary x scale, x', has been used, with 60 months equal to zero.

ANALYSIS OF DATA

As a result of fitting the equation to the successive weights of each child included in the study, there was available for each of the 301 children an estimate of his average monthly percentage gain in weight. These estimates were put in rank order for the children in each "physical fitness" group, and the following statistics were calculated:

(1) Mean average monthly percentage gain in weight and its probable error.

(2) Median average monthly percentage gain in weight and its probable error.

(3) Percentage of children whose average monthly percentage gain in weight was less than 0.80 (the approximate modal average monthly percentage gain in weight of the 301 boys and girls included in the study), and the probable error of the percentage.

These statistics and the number of children in each of the six physical-fitness groups are shown in Table 2. The findings are as follows:

(1) Within each milk-consumption group, the children whose general nutritional status was assessed as "Excellent or good" gained faster on the average than the children whose general nutritional status was assessed as "Borderline"; those whose general nutritional status was assessed as "Borderline" gained faster on the average than those whose general nutritional status was assessed as "Poor or very poor." This finding holds for every physical-fitness group shown in Table 2, except one (no. 5).

Within each nutritional-status group, the children whose milk consumption was adequate gained faster than the children whose milk consumption was inadequate.

(2) Within each milk-consumption group, the percentage of children who gained less than 0.80 per cent per month was less for the children whose general nutritional status was assessed as "Excellent or good" than for those whose general nutritional status was assessed as "Borderline;" the percentage of children who gained less than 0.80 per cent per month was less for the children whose general nutritional status was assessed as "Borderline" than for those whose general nutritional status was assessed as "Poor or very poor." This finding holds for every physical-fitness group in Table 2, except one (no. 5).

Within each nutritional-status group, the percentage of children who gained less than 0.80 per cent per month was less for the children

TABLE 2

Mean and median average percentage gain in weight per month of boys and girls, 6 to 7 years old, of Italian ancestry, who were weighed at stated intervals during the school years 1934-35 and 1935-36, grouped according to clinical assessment of general nutritional status and adequacy of milk consumption, and percentage of these boys and girls whose average percentage gain in weight per month was less than 0.80; New Haven, Conn.

PHYSICAL-FITNESS GROUP (GENERAL NUTRITIONAL STATUS AND MILK CONSUMPTION*)	MEAN OR MEDIAN AVERAGE PERCENTAGE GAIN IN WEIGHT PER MONTH		PERCENTAGE OF CHILDREN WHOSE AVERAGE PERCENTAGE GAIN IN WEIGHT PER MONTH WAS LESS THAN 0.80	NUMBER OF CHILDREN
	Mean	Median		
1. "Excellent or good" nutritional status; adequate milk consumption.....	1.10 ± 0.038	1.05 ± 0.048	9.1 ± 4.1	22
2. "Excellent or good" nutritional status; inadequate milk consumption..	1.02 ± .022	.97 ± .028	14.3 ± 3.2	56
3. "Borderline" nutritional status; adequate milk milk consumption.....	.91 ± .021	.93 ± .026	38.6 ± 5.0	44
4. "Borderline" nutritional status; inadequate milk consumption	.83 ± .010	.82 ± .012	46.5 ± 2.8	144
5. "Poor or very poor" nutritional status; adequate milk consumption	.91 ± .039	.80 ± .048	28.6 ± 11.5	7
6. "Poor or very poor" nutritional status; inadequate milk consumption	.81 ± .024	.74 ± .030	60.7 ± 6.2	28

* Nutritional status assessed by a pediatrician. For definition of adequate milk consumption see section entitled *"Adequacy of diet."*

whose milk consumption was adequate than for those whose milk consumption was inadequate.

These findings are based on an estimate of gain in weight in percentage form, derived by using a statistical procedure which is too complicated for practical application. Even if a simplified method were used which takes into account, for example, only the initial and final weighings made during the period of observation, it would still be necessary to calculate the percentage which the actual gain in weight is of the initial weight. Fortunately, however, this step is unnecessary, for analysis shows that a high correlation exists between a child's average percentage gain in weight per month and his absolute gain in weight during the period of observation (19 or 20 months). See Table 3. The correlation coefficient derived from the observations in this table is 0.84 ± 0.011.

These findings indicate that the 6-year-old child's absolute gain in weight may be used as one index of his physical fitness to be compared with the average gain of a large group of healthy children of the same race, ancestry, sex,[11] and age. Such standards are not available, and the need for them is apparent.

DISCUSSION

The findings indicate the value of gain in weight as an index of the physical fitness of 6-year-old children. As children of this age form a more homogeneous group with respect to growth and development than either older or younger children, the value of gain in weight as an index of the physical fitness of older or younger children can not be inferred from these findings for children 6 years of age.

Note also that the limitations of gain in weight as an index of physical fitness are well recognized. Gain in weight may or may not reflect a child's condition, but any gross variation can be followed up and its cause ascertained. See, for example, the procedure used in the London (England) County Schools (4). In these schools every child who is under the age of 12 is measured and weighed every 6 months. A graphic weight-and-height card is used, and the nurses are instructed to bring before the school doctors for special examination and study

[11] See footnote 3. The mean or median average percentage gain in weight of the boys tended to be smaller than the corresponding averages for the girls.

TABLE 3

Correlation between absolute gain in weight and average percentage gain in weight per month of boys and girls, 6 to 7 years old, of Italian ancestry, who were weighed at stated intervals during the school years 1934-35 and 1935-36; New Haven, Conn.

AVERAGE PERCENTAGE GAIN PER MONTH	ABSOLUTE GAIN (LBS.) DURING PERIOD OF OBSERVATION																
	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9	TOTALS
0.40 - 0.49	1	3	1	...	...	...	...	...	...	...	...	...	...	...	...	...	5
0.50 - 0.59	...	1	5	2	...	...	...	...	...	...	...	...	...	...	...	...	8
0.60 - 0.69	...	3	10	13	6	2	...	...	...	...	...	...	...	...	...	...	34
0.70 - 0.79	...	1	8	20	24	10	2	1	...	...	...	...	...	...	...	...	66
0.80 - 0.89	...	...	...	5	14	18	8	3	1	...	1	1	...	...	...	...	51
0.90 - 0.99	...	...	...	...	7	19	22	9	2	1	1	...	...	...	1	...	62
1.00 - 1.09	...	...	...	...	3	6	6	6	6	1	...	1	...	...	...	...	29
1.10 - 1.19	...	...	...	...	...	2	3	4	7	4	2	...	...	...	...	...	22
1.20 - 1.29	...	...	...	...	...	...	...	...	3	1	...	...	2	1	...	...	7
1.30 - 1.39	...	...	...	...	...	...	...	2	3	2	1	...	...	...	...	...	8
1.40 - 1.49	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	2
1.50 - 1.59	...	...	...	...	...	...	...	...	...	...	...	1	...	2	...	1	4
1.60 - 1.69	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	2
1.70 - 1.79	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
TOTALS	1	8	24	40	54	57	41	25	22	9	6	4	2	3	3	2	301

all children whose progress is not satisfactory according to certain prescribed standards.

SUMMARY

The average monthly percentage gain in weight, over a period of 19 or 20 months, of each of 301 white New Haven school children of Italian ancestry, 6 to 7 years old, all born in the United States, was estimated in terms of the b constant of the exponential equation, $y = ae^{bx}$, fitted to stated weighings of the child made during the school years 1934-35 and 1935-36. Average monthly percentage gain in weight was tested as an index of physical fitness, using as a criterion the combination of two types of observations made on each child: (1) Clinical assessment of general nutritional status; (2) adequacy of milk consumption as an indication of adequacy of diet. The findings were as follows:

(1) Children in the same milk-consumption group whose general nutritional status was assessed as "Excellent or good" gained faster on the average than those whose status was "Borderline"; children whose status was "Borderline" gained faster than those whose status was "Poor or very poor."

(2) Children of the same general nutritional status whose milk consumption was adequate gained faster on the average than those whose milk consumption was inadequate.

These findings indicate that, on the average, percentage gain in weight reflects the physical fitness of children, as judged both in terms of (1) clinical assessment of general nutritional status and (2) adequacy of milk consumption as an indication of adequacy of diet.

As a high correlation was found between the absolute and the percentage gain in weight of these children, the findings have practical significance: The absolute gain in weight of 6-year-old children may be used as an index of their physical fitness.

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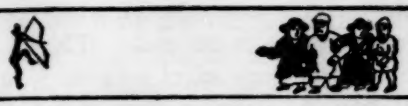


THE SKELETAL AND DENTAL DEVELOPMENT AND VARIABILITY OF THE GORILLA

(*Continued*)

BY FRANCES E. RANDALL

Departments of Anthropology and of Biology, Harvard University

Indices

ALTHOUGH metric data are necessary in order to follow the absolute pattern of growth, indices are also necessary to indicate relative rates. For this reason, three indices were calculated. These were the total cranial, the upper facial, and the external palatal. A fourth index, the partial cranial, that is, the index based on the cranial length and the maximum breadth to the squamous suture, was calculated from the means of the dimensions without testing the statistical deviations.

Cranial index

This index, as will be described under the section on variations, yielded one of the most important tests of both growth and variation.

	Male Per cent of Stage VI	*Female* Per cent of Stage VI
Stage I*	100.1	96.5
II**	101.4	98.8
III	104.6	98.9
IV	107.0	99.9
V	103.8	101.4
VI	100.0	100.0

* Unsexed.

** Tentatively sexed.

The male index increases up to Stage IV, and the female increases up to Stage V. The rate of increase for the breadths is greater than that

for the lengths, but after IV the breadth rate falls off, while the maximum length keeps on and even increases in the male. Thus a statistically significant decrease occurs in the male index between V and VI. The female follows somewhat later with her cresting factor and decreases the index later also. However, her decrease is not of statistical significance.

One very important precaution *must* be introduced at this point. The indices represent means, but in plotting the Stage VI indices we do not find normal distributions. These variations and their implications will be discussed later. But, the fact that means and statistical constants based on atypical distribution curves are very poor makes it imperative that this reservation be kept in mind. It is the opinion of the author that these arithmetic means obtained from unsorted data are the causes of common errors in the assessment of variations.

Upper facial index

Although the range of 10 units in this index is rather small, the fact that it shows the pattern which it does is interesting.

As shown by the means in the appended tables, the male shows a relative lengthening of the face during the middle portion of the growth period; this is followed by a relative broadening due to greater growth in the bizygomatic arches during the later portion of the period. The female, however, shows a relative broadening during the middle portion, with lengthening later. In the male, it is during Stages III and IV that the greatest amount of anterior facial growth occurs.

Palatal index

The palate of the female remains relatively broader than that of the male even while it is increasing in relative length. There is a statistically significant increase in the final period.

The study of metric and indicial aspects of growth in the skulls shows that the male enjoys what might be termed a "masculine exuberance" following the onset of Stage IV. This is mirrored in both the metric and indicial values.

Temporal lines

One of the best indications of approaching maturity in the two sexes is the development of the crests. In the early ages this is heralded

by the approach of the two temporal lines. Stage I is so immature that only six of sixteen skulls studied presented lines which were definite enough to measure. These six presented a minimum breadth of 66.5 mm. As early as Stage II, the approaching sex divergence shows its beginning, with the male, oddly enough, being the greater in the width, 59.4 mm., and the female being 53.7 mm. This reversal of dimension continues into Stage III, where the male has a measurement of 43.0 mm. and the female 33.9 mm. But, as usual, Stage IV sees the male speed, and we now find that it is only 15 mm. and the female is 25.5 mm.

By Stage V, the sagittal crest has formed in 47 of the 62 male skulls studied, with the temporal lines in the remaining 15 being only an average of 2.6 mm. apart. In the latter there is merely a groove lying between the humped-up temporal lines which are almost ready to fuse into the crest. The female presents a corresponding average of 11.4 mm.

By Stage VI, the males all present crests in varying degrees. Of 88 females observed at this stage, 12 have crests to some degree, and 61 have the temporal lines joined, even though a distinct crest may not be present. The remaining 27 have an average minimum breadth between temporal lines of 3.1 mm.

In summation, we may state that the early male lag behind the female shows in crest formation as it does in certain metric growth rates. But after Stage IV, the masculine factor becomes dominant, and the female is surpassed at a rapid rate.

Suture closure

Although Krogman (1930b) already has presented a study on suture closure in the gorilla, the larger population available to the author presents an opportunity to obtain more reliable statistical assessment of the closures at various dental stages. These are presented in terms of the percentage which has reached complete, partial, or no closure. Nine sutures were assessed. These are listed in tabular form below.

Stage I (Unsexed)

	Open	*Partial*	*Complete*
Basi- and lateral occiput	100.0	0.0	0.0
Lateral and squamous occiput	35.6	64.4	0.0
Basilar	100.0	0.0	0.0
Coronal	100.0	0.0	0.0
Sagittal	100.0	0.0	0.0
Lambdoid	100.0	0.0	0.0
Internasal	18.8	56.2	25.0
Intermaxillary	93.8	6.2	0.0
Palatal	100.0	0.0	0.0

Only three of the nine sutures studied showed any degree of closure before Stage II. The internasal suture is most advanced, with the sutures between the lateral and squamous occipital bones next in extent and the intermaxillary suture third. The internasal suture begins its closure superiorly and proceeds inferiorly. The sutures between the squamous occipitals begin medially and progress laterally. The intermaxillary sutures begin within the alveolar margins around it, and then proceed superiorly.

Stage II sees a considerable increase.

Stage II (Tentatively sexed)

	Open		*Partial*		*Complete*	
	M	F	M	F	M	F
Basi- and lateral occiput	11.6	14.3	17.7	14.3	70.7	71.4
Lateral and squamous occiput	5.8	14.3	17.7	14.3	76.5	71.4
Basilar	100.0	100.0	0.0	0.0	0.0	0.0
Coronal	96.0	100.0	4.0	0.0	0.0	0.0
Sagittal	91.0	100.0	9.0	0.0	0.0	0.0
Lambdoid	86.5	100.0	13.5	0.0	0.0	0.0
Internasal	4.5	14.3	54.5	38.5	40.0	57.2
Intermaxillary	100.0	100.0	0.0	0.0	0.0	0.0
Palatal	95.0	85.7	4.0	14.3	0.0	0.0

Seven sutures of the males, and four of the females have now begun to close. The sutures between the basi- and lateral occipitals and the sutures between the lateral and squamous occipitals are far along and the internasal suture is further along than in Stage I.

Stage III

	Open		*Partial*		*Complete*	
	M	F	M	F	M	F
Basi- and lateral occiput	0.0	0.0	0.0	0.0	100.0	100.0
Lateral and squamous occiput	0.0	0.0	0.0	0.0	100.0	100.0
Basilar	100.0	100.0	0.0	0.0	0.0	0.0
Coronal	100.0	100.0	0.0	0.0	0.0	0.0
Sagittal	95.0	91.8	5.0	8.2	0.0	0.0
Lambdoid	84.3	75.0	5.3	0.0	10.4	25.0
Internasal	0.0	16.7	42.0	33.3	58.0	50.0
Intermaxillary	100.0	100.0	0.0	0.0	0.0	0.0
Palatal	58.0	83.4	36.8	8.3	5.2	8.3

It will be noticed that certain atypical closures were encountered. In Stage I, an intermaxillary suture showed some closure, while none shows in Stages II and III. A coronal suture showed partial closure in II, while none shows in III. This is not unusual, because these are also encountered in other forms . This early appearance of closures is paralleled by late closures lasting into Stage VI.

Stage IV again sees great progress in the maturation rate.

Stage IV

	Open		*Partial*		*Complete*	
	M	F	M	F	M	F
Basi- and lateral occiput	0.0	0.0	0.0	0.0	100.0	100.0
Lateral and squamous occiput	0.0	0.0	0.0	0.0	100.0	100.0
Basilar	100.0	81.7	0.0	9.1	0.0	9.1
Coronal	86.3	81.7	10.3	9.1	3.4	9.1
Sagittal	45.0	27.2	31.0	36.4	24.0	36.4
Lambdoid	27.6	18.1	17.3	18.1	55.1	63.7
Internasal	0.0	0.0	31.0	10.0	69.0	90.0
Intermaxillary	79.5	82.0	20.5	18.0	0.0	0.0
Palatal	58.6	63.6	38.0	18.1	3.4	18.1

The coronal suture is variable in its closure. It may close throughout its entire length, or either end may begin first. The sagittal suture begins its closure posteriorly and then it proceeds anteriorly. The lambdoid suture closes rather constantly throughout its entire length.

Stage V exhibits a continuation of the pattern established in IV. The palatal suture is further advanced in its obliteration. This shows

first in the posterior section but occasionally also in the anterior section at the same time. The middle is the last to complete its closure.

Stage V

	Open		*Partial*		*Complete*	
	M	F	M	F	M	F
Basi- and lateral occiput	0.0	0.0	0.0	0.0	100.0	100.0
Lateral and squamous occiput	0.0	0.0	0.0	0.0	100.0	100.0
Basilar	61.8	34.5	30.2	31.0	8.0	34.5
Coronal	25.8	35.5	37.1	19.4	37.1	45.1
Sagittal	3.2	9.9	17.8	22.6	79.0	67.5
Lambdoid	3.3	3.2	0.0	3.2	96.7	93.6
Internasal	3.3	0.0	11.5	22.6	85.2	77.4
Intermaxillary	26.3	19.3	49.2	61.4	24.5	19.3
Palatal	36.7	29.0	45.1	64.5	18.2	6.5

In Stage VI most of the sutures are closed. Since the closure of the basilar suture is indicative of the onset of Stage VI, it is always closed. The others show some variability in their stages of obliteration.

Stage VI

	Open		*Partial*		*Complete*	
	M	F	M	F	M	F
Basi- and lateral occiput	0.0	0.0	0.0	0.0	100.0	100.0
Lateral and squamous occiput	0.0	0.0	0.0	0.0	100.0	100.0
Basilar	0.0	0.0	0.0	0.0	100.0	100.0
Coronal	0.7	5.5	0.0	5.5	99.3	89.0
Sagittal	0.0	0.0	0.0	2.0	100.0	98.0
Lambdoid	0.0	0.0	0.7	0.0	99.3	100.0
Internasal	0.0	0.0	0.5	1.0	99.5	99.0
Intermaxillary	0.0	0.0	5.8	7.6	94.2	92.4
Palatal	0.5	12.0	6.0	16.3	93.5	71.7

The final stage emphasizes further that the female lags behind the male in reaching complete suture closure in relation to the dental pattern attained.

Metopic sutures were observed in only two cases in the lower four stages, one female Stage II, one male Stage II.

Recording the variation in the formation of the pterion is difficult,

because the older skulls have this region obliterated and cannot be assessed. For this reason, any percentages recorded would be based upon small series only. It must suffice to note that only four skulls showed a form other than the tempero-frontal articulation. One skull of Stage II had a pteric fontanelle bone on the right side, with an alisphenoid-parietal articulation on the left. One skull of Stage IV had an alisphenoid-parietal suture on the left, while the right was as usual. The third and fourth skulls, Stage V, had the reverse. All these skulls are males.

Cranial and dental variability

Having treated the metric data and the assessment of suture closure as rather constant factors, we now proceed to a more detailed discussion of the variabilities of certain traits throughout the age stages and in the two sexes. We have two methods of approach to this consideration, purely descriptive and statistical. Pathological variations will be considered in connection with the discussion of the skeleton as a whole.

Certain traits show such high variability that it is best recorded in tables of percentage occurrence.

The frequency and size of the cranio-pharyngeal canal is of this nature. Its presence, complete or incomplete, and its relative size, either large or small, has been noted (o = absent, + = small, ++ = large).

Cranio-pharyngeal canal

	Male			*Female*		
	o	+	++	o	+	++
Stage I	8	84	8	Included with males		
Stage II	19	62	19	14	72	14
Stage III	33	56	11	20	60	20
Stage IV	38	59	3	50	40	10
Stage V	34	57	9	31	66	3
Stage VI	44	51	5	60	38	2
Total (II-VI)	38	54	8	48	47	5

These data indicate that the females have more cases in which the canal is entirely absent, and the males have more large canals than do the females. There is also some evidence that there may be a pro-

gressive closing of these canals with increasing age, although the data are not conclusive.

The infra-orbital foramina showed an extremely high variability, and for this reason were noted. They might be single in form or double. This condition might be either bilateral or unilateral.

Infra-orbital foramina

	Male			*Female*		
	Both double	Both single	One single, one double	Both double	Both single	One single, one double
Stage I	50 0	25.0	25.0	Included with males		
Stage II	77.3	13.6	9.1	57.0	29.0	14.0
Stage III	58.0	32.0	10.0	92.0	8.0	0.0
Stage IV	38.0	35.0	27.0	55.0	27.0	18.0
Stage V	56.0	35.0	9.0	32.0	39.0	29.0
Stage VI	44.7	33.3	22.0	49.0	35.0	16.0
Total (II-VI)	50.0	32.1	17.9	49.7	32.6	17.7

No growth or sex differences are represented in this table, but it will be noted that the variations present are very high.

The positions and the conditions of the palate and of the teeth are also indications of growth and of age. Thus certain variabilities were recorded for these traits. Wear of teeth is diagnostic of age, so its conditions were recorded. In the lower two stages, the situation of the deciduous teeth was noted, while in the upper four, the permanent teeth could be observed.

Tooth wear

	Male				*Female*			
	O	+	++	Extreme	O	+	++	Extreme
Deciduous								
Stage I	60.0	40.0	0.0	0.0	Included with males			
Stage II	50.0	41.0	9.0	0.0	57.0	43.0	0.0	0.0
Permanent								
Stage III	90.0	10.0	0.0	0.0	83.0	17.0	0.0	0.0
Stage IV	100.0	0.0	0.0	0.0	91.0	9.0	0.0	0.0
Stage V	65.0	30.0	5.0	0.0	64.5	29.0	6.5	0.0
Stage VI	0.7	36.7	46.2	16.4	0.0	34.9	49.5	15.6

The two sexes show the same degrees of wear as age proceeds.

The condition of the type of occlusion of the incisors shows an interesting parallelism to that existing in the human growth pattern. That is, the period during which the incisors are erupting is one in which a disharmony develops which is not indicated in either the younger or the older periods. This is called the "Ugly Duckling" stage in the human being. The upper incisors overlap the lowers to a considerable extent so that there is a very high incidence of overbite. This may be due to one or the other, or both, of two factors. Either the incisors erupt in a different position than they eventually attain, or the mandibular growth may lag behind that of the palate to some extent. It is probable that both factors may be involved.

Bite

	Male			*Female*		
	Under-	Edge-	Over-	Under-	Edge-	Over-
Stage I	0.0	78.0	22.0	Included with males		
Stage II	0.0	92.0	8.0	0.0	100.0	0.0
Stage III	0.0	28.0	72.0	0.0	44.0	56.0
Stage IV	0.0	63.0	37.0	0.0	38.0	62.0
Stage V	0.0	71.0	29.0	4.0	75.0	21.0
Stage VI	1.9	80.5	17.6	2.8	84.5	12.7

Stage III and, to some extent, Stage IV show the high frequency of the overbite during the incisor eruption period. The incidence of underbite is very low.

A sex difference was encountered in the breadth of the second molars. The upper molar of the male shows an average of 16.8 mm., while that of the female is 15.5 mm. The lower molar is smaller in both sexes. That of the male is 15.7 mm., and that of the female is 14.5 mm. The upper canine of the adult male has a vertical crown length of 35.8 mm., and the lower, 31.8 mm. In the female, the upper canine is 20.3 mm., and the lower is 19.2 mm. Statistical constants for these dimensions are listed at the end of this section. It should be noted, however, that the canines show an extremely high variability. This is partly due to attrition in the adult tooth. Wear begins on these teeth almost as soon as they are fully erupted.

Of special interest in the consideration of teeth is the occurrence

of supernumerary teeth or, of equal importance, reductions in the dentition. One Stage-II male skull had six upper deciduous incisors with the centrals appearing to be the double ones. A Stage-V female had five upper permanent incisors with three lying to the left of the midline; the palate was also asymmetrical. Still another female skull, of Stage VI, had five lower incisors. One other skull, a Stage-VI male, had only three lower incisors with no indication of a fourth having been present. A Stage-V male had what appeared to be a congenital absence of M3 on the lower left. However, it may have been impacted. Numerous cases of splitting of molars were observed, with occasional portions of the tooth being carried free of the crypt while being held in place by the rest of the tooth, to which it was still attached. Crowding of teeth was relatively rare. Occasionally the incisors might be a little angulated or the premolars squeezed in, but never to any marked degree.

Sagittal Wormian bones occurred in 11 skulls, all of Stage IV or less. Three skulls of Stage I, three of Stage II, three of Stage III, and two of Stage IV showed them. Of the stages above I, only one was female.

Two lambdoid Wormian bones were encountered, both males, one being Stage II and the other, Stage III.

Fontanelle bones were found in nine skulls. Five had anterior and four had posterior ones. Of the five anteriors, four were male and one, female. The four posteriors were two male, one female, and one Stage I.

Five skulls, three male and two female, show supernumerary sutures. A Stage-II male had the right parietal bone bipartite with an extra suture paralleling the squamous suture. Another Stage-II male had an extra suture in the left frontal bone. A Stage-IV male had an extra suture in the zygomatic process of the left maxilla, dividing the bone into an upper and a lower portion. A Stage-III female also had the left frontal bone divided by a suture lying about 30 mm. above the temporo-frontal suture and joining the coronal suture to the zygomatico-frontal one. The other female, a Stage-V, had a horizontal suture lying in the left nasal bone.

Although the frequency was not recorded, occurrences of extra sutures within the maxillae and the premaxillae, were very common. One case was found in which horizontal sutures lay in the premaxillae, dividing them into an alveolar portion and a nasal portion.

An exostosis was found in a great number of skulls of both sexes lying on the anterior margin of the foramen magnum at the point occupied by basion and also at the point where the ligament extending from the odontoid process attaches. A few of these exostoses were found at the posterior margin also. The author has seen only one marked development of this type in human skulls, and it was on an Australian skull.

Numerous variations in the crests were found, but the type and number were not recorded. The variations were not so much in position as in minor fluctuations of contours. Also, venous canals often pierced the crests.

From the relative frequencies discussed above, it will be seen that the male skulls appear to have a greater variability than do the females. Thus, the sex variability which was encountered in the metric analysis is reflected in the morphological analysis.

The second method in the analysis of variation is one of statistics. The arithmetic mean, the standard deviation, the standard error, the coefficient of variability, and the range were used. Contingency tables were used for testing the significances of certain morphological traits.

The full tables of statistics are listed at the end of this section. A brief discussion of the entire group will suffice at this point. The eighteen metric traits, along with the three indices derived from them, were tested. The groups of the males were sufficiently large so that almost the entire age ranges could be tested. The females, however, were scarce in the lower four stages, so had to be limited to means and ranges.

Although the entire set was not calculated for each age in the males,

Mean coefficients of variation

	*Total**		*12 traits only***		
	Male	Female	Male	Unsexed	Female
Stage I	...	...	...	9.55	...
Stage II	6.86	...	6.84	...	...
Stage III	5.87	...	6.47	...	...
Stage IV	8.19	...	8.50	...	...
Stage V	7.14	5.61	6.98	...	5.26
Stage VI	6.34	5.97	5.88	...	6.02

* Total of all coefficients of variation of any one group.

** Twelve traits common to all age groups.

there was a number sufficiently large to obtain an estimate of the variabilities and their fluctuations from age to age. These mean variabilities are merely the average of all the coefficients of variation.

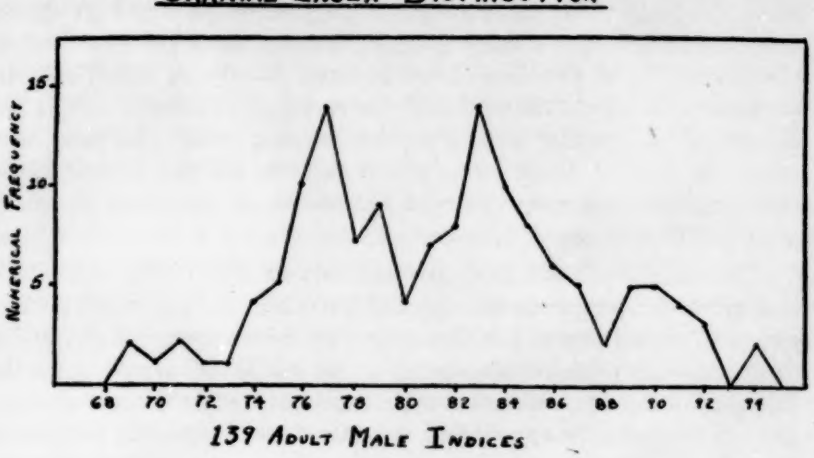
This table offers interesting implications. We see that the male variability decreases from Stage I to Stage III, then jumps up, and decreases again. But the final variability of Stage VI is larger than that of Stage III. Thus, we see that our masculine spurt in growth is reflected in the variabilities. The low values for the last two stages available for the females show how small their variation is compared to that of the males. It also shows that there is very little change from Stage V to Stage VI, whereas the male shows considerable change.

The traits showing the greatest variabilities are the interorbital breadth, the orbital capacity, and later, after Stage IV, the total skull height and the cranial capacity. This holds for both sexes.

In studying variations, it is just as important to test the populations for heterogeneity as it is to test them for homogeneity. This, after all, is the basis for all biological nomenclature. We first attempt to recognize homogenous groups based upon certain arbitrary gross examinations. But we often find that these arbitrations may ultimately be insufficient to describe adequately the full aspect of the group. It is upon these more detailed differences that sub-species are based. Thus, an attempt was made to analyze the population under consideration for indications of heterogeneity overlying the more apparent aspects of homogeneity common to the genus *Gorilla*. This was considered to be of value, not as an aspect of growth so much as an attempt to associate a relatively good statistical sample with those statements made by earlier workers on much smaller groups. The descriptions of Wyman (1847), Matschie (1904), and others were based upon single or, at best, only a few skulls. The number studied by Coolidge (1929) in his *Revision of the Genus Gorilla* was of suffcient size for an analysis, but none was made beyond gross means and ranges. With all due respect to these previous descriptions of variations in gorilla, the author feels that the data presented herein may offer a greater understanding of this particular problem and may serve as a stimulus for later work to be done along this particular line.

As was suggested under the discussion of the metric traits including the crests, there seems to have been an incomplete picture presented of the importance of these structures along with certain other structures cosely allied with them.

Absolute dimensions indicate many relationships among skulls or of any other measurable substances, but, especially in craniometric studies, the cranial index and its allied indices on the skull are of utmost importance for the full understanding of skull formations. For this reason, the cranial indices of the adult skulls, Stage VI, were plotted as frequency polygons in Figure 1.



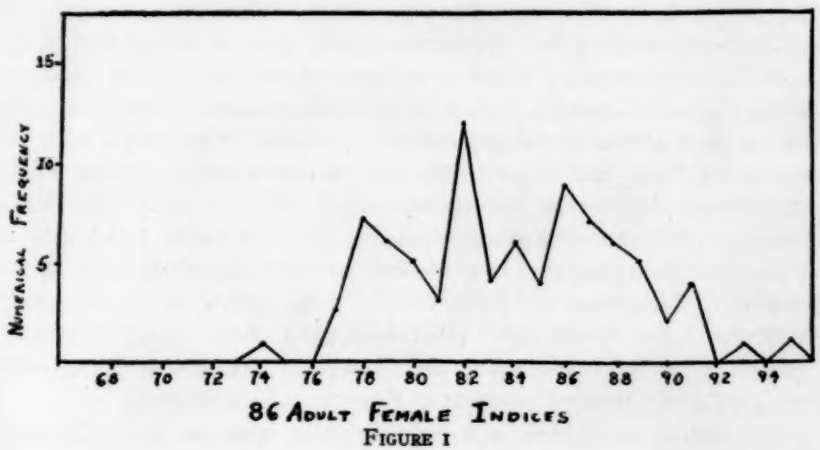


FIGURE 1

As is easily seen from the male plot, a marked dichotomy exists, and even a possible trichotomy may be present. It should be made perfectly clear at this point that there is no influence in this plot due to the ages of the skulls so far as can be determined. The degree of attrition of the teeth and the condition of the sutures were carefully studied to ascertain this fact. Thus, all conclusions derived from the following data must be taken without making a reservation based on age. The graph of the distribution for the males has a very high significance. The Chi square value is 44.88, whereas the 1 per cent level of significance for eleven degrees of freedom is only 24.72. Thus, the distribution is beyond the probability of a chance distribution. The Chi square for the females is near the 10 per cent level. We have here, again, the marked dissimilarity shown between the two sexes. However, the same tendency toward a bimodality of the curve is shown, even though it is not so pronounced.

The male skulls will be considered first in detail. The hypothesis that must be taken from this marked bimodality (the possible trichotomy was not considered) is that there may be a sub-special dichotomy or dimorphism in the skulls due either to cristal differences or to the existence of further differences which are mirrored in the cristal bimodality. Assuming this possibility, we should attempt to find just where the differences occur. Are the two modes of the curve due only to crests or are there further differences? The heterogeneity is statistically significant. Are there any other traits which show this significance on those skulls which fall into the two large groups? In order to test this, there must be made some arbitrary division. This division was made at an index value of 80. No skulls at this value were included in the tests for significance. There is no way of ascertaining the termination of the two curves, if such a termination exists. Approximately 94 per cent of the Broad population is included in its curve, with the remaining 6 per cent thrown over into the other curve. In the Long, 92 per cent falls under the curve, with 8 per cent under the Broad curve. A full statistical study was made of all 18 metric and 3 indicial traits for each group. These studies are included at the end of the section. The groups are listed as B and L, with B being the group with the higher index and L that with the lower. Group B may be spoken of as the Broad group and L as the Long group. Traits are analyzed and compared in tables at the end of this section.

In testing the metric and indicial traits, nine metric traits were

found to be statistically significant in their differences. Two other metric traits were moderately significant in their differences. Those metric traits of highly significant differences were cranial capacity, maximum length, cranial length, inion-prosthion, maximum breadth to suture, total maximum breadth, postorbital breadth, biorbital breadth, total skull height, and the last two, of moderate significance, the basion-prosthion and the bizygomatic breadth. It will be seen from this enumeration that some of the traits are not concerned with the cresting factor directly but may be allied with it. These are the total maximum breadth, the cranial length, maximum breadth to suture, biorbital breadth, and, possibly, the postorbital breadth. The last dimension was shown to decrease in company with the increase in the biorbital dimension during the growth process.

Only the cranial index, which was the original basis of the division of the two groups differed significantly. The upper facial index and the palatal index were not significant in their differences.

Certain observations on the teeth showed interesting differences. Group B showed significantly higher degrees of attrition. This fact, in itself, should show that the cresting factor is not dependent on the age of the skulls. If it were, the older skulls should have the greater crests, but they do not. There is a bare possibly that the crests may atrophy in later age, producing a reverse process from that expected. Group B also shows a higher incidence of alveolar abscessing than does Group L, but the difference is only of moderate significance statistically.

The mean variability of Group B is 6.03, while that of Group L is 6.43. Twelve trait variation means are: Group B, 6.10 and Group L, 6.12. The mean variability for the entire group of males is 6.34, and the twelve trait variation is 5.88. Thus, Group B is less variable than is the total, and Group L is about the same. We have in this fact the usually unrecognized situation that a "sub-species," if it is such, may show about the same variabilities as does the species as a whole and yet indicate dimorphism. In the discussion of variations made by Coolidge, he continually made the statement that various sub-special descriptions all fitted within the limits of variation for the entire group. This statement is prefectly true, but such factors as predominance of traits peculiar to any one group were not analyzed by him.

As in all situations in which heterogeneous groups are encountered, an effort must be made to find why such a thing has happened. The

statistical analysis has shown that there are at least two significant types of skulls in the adult male population. The first question which should be answered is that of geographical origin. This is particularly difficult because the sites from which the material was obtained are very seldom recorded, leaving only a broad region from which the population may have arisen. Because of this fact, the material was divided roughly into Cameroons and Gaboon, including French Congo. We have what roughly constitutes a northern, the Cameroons, and a southern, the Gaboon, geographical environment. Groups B and L were broken down into these two sub-groups and recorded by percentage and numerical frequency.

	Group B		*Group L*	
	Per cent	Number	Per cent	Number
Cameroons	69.0	76	31.0	34
Gaboon	42.5	28	57.5	38

It should be noted that all the data listed by Coolidge were included in this breakdown. It was fortunate that he took the maximum cranial length and the maximum mastoid width the same was as was done in this study. Those skulls which were measured by both Coolidge and the author were checked and were found to support the use of his data. By combining the European data of Coolidge and the American data of this paper, it was possible to allocate 176 adult male skulls. A Chi square calculated from these data was found to be 12.14, which is highly significant. We may conclude that we have established two geographical types of skulls. The Cameroons skulls are predominantly broad in their structures, and the Gaboon skulls are predominantly long. It must be remembered that these relative distributions can in no way be taken as representative of the actual population distribution. The collection at Western Reserve University is predominantly the Cameroons type, whereas those collections at the United States National Museum and at the American Museum of Natural History are about evenly divided, and the European groups studied by Coolidge had a high percentage of the Gaboon type, due to the large Rothschild collection. Our museum populations represent only the material most easily obtained by collectors. What the relative sizes of the populations are in the two regions cannot be ascertained, and whether further subgroups may exist within the two regions is still doubtful. From the

data available, that is, the study of the skulls, it appears that there are two main types, with the geographical limitations of each and both unknown. A distribution curve made with the addition of the Coolidge data indicates that a third hyperbrachy type is probably present, but this type is also found in both the geographical regions, with a predominance in the Cameroons.

The second problem which must be considered in heterogeneous groups such as were encountered in these skulls is that of finding how other traits, such as those on the skeleton and on the skin and pelage are correlated. This problem was considered so far as possible for the skeleton and will be discussed later. The correlations with the pelage could not be attempted because of the scarcity of material.

As was stated earlier, the female skulls did not show the marked dimorphism which was shown by the males, but, since the trend was indicated, an arbitrary division was made at an index value of 84. The higher index group above this value was termed B again, and that below, L.

The two sub-groups were analyzed in the same manner as were the males, and the following traits were found to be significantly different: orbital capacity, maximum length, cranial length, maximum breadth to suture, total maximum breadth, interorbital breadth, bizygomatic breadth, palate breadth, and the cranial height. Only the cranial index was significantly different in the indicial analysis. Here, again, a relative linearity was found as compared to the laterality of the B group. The lateral dimensions were less in Group L, and the longitudinal values were greater in Group L than in Group B. Group L had a mean variability of 5.94 and a twelve trait variation, 5.16. The variability of the total group was 5.97 and 6.02, respectively. In both sexes the L group is about as variable as is the total, while the B group is less variable.

In the assessment of the conditions of the teeth, etc., Group L was found to have somewhat more loss of teeth than did Group B, but the difference was not of high significance. However, it was found that Group L had significantly more single infra-orbital foramina than did Group B.

A final discussion of the dimorphism will be made in the chapter of conclusions. Before proceeding to the chapter on the skeleton, is should be stated that, even though this study was not designed to inquire into the problem of sub-special variation in *Gorilla*, certain facts were so

self-evident that some comment should be made concerning them. Lord Rothschild (1923) defined the entire group of gorillas as:

Gorilla gorilla gorilla (Gaboon)

Gorilla gorilla diehli (Cameroons)

Gorilla gorilla beringei (Mountain)

Since we are not concerned with the Mountain gorilla at all, it is interesting to note that Rothschild did recognize the dimorphism which has manifested itself in this study. Bunack (1923) created a "crest factor" which he said was symptomatic of certain species and subspecies of primates. Rothschild also used this factor in his definitions. He states, "The most essential differences of the three races are, however, in the skulls: *Gorilla gorilla gorilla* has the occipital region narrow and appearing almost triangular, owing to the lambdoid crest running up to a sharp point in the center. *Gorilla gorilla diehli* has the occipital region very broad and the lambdoid crest in the center only rises to a low blunt point." This statement agrees perfectly with the statistical conclusions arrived at in this study. There is only one doubt in the author's mind and that is that there may be a third variant having its mode also in the Cameroons and having an extremely short cranium. Unfortunately, this matter cannot be considered until there are better notes recorded as to the exact geographical origin of the animals. The author does not wish to offer any conclusions regarding taxonomy in this paper, but he does wish it to be noted that the analysis presented agrees with that of Rothschild and not that of Coolidge. Since the data recorded by Coolidge were composed mainly of Gaboon gorillas, it should be evident that it could not show, by statistical analysis, such a clear dimorphism as did that made by combining the large Cameroons collection with the Gaboon data already obtained by Coolidge. Here again, the criticism is not with the person concerned but with the lack of material. It is very probable that still larger amounts of material will yield a greater understanding of this very interesting problem.

Sub-I Skulls

Four young skulls which did not, as yet, have the complete deciduous dentition were encountered. Since these could not be grouped with

Stage I skulls and did not constitute a fair sample, they will be discussed only very briefly. Means of the metric values are listed in the tables.

All four showed a small cranio-pharyngeal canal. All had temporo-frontal sutures. No dental variations appeared. The sequence of eruption will be shown in the dental eruption chart. Three skulls showed complete closure of the internasal sutures, and the fourth still had the lower one-half open. Greatest palate breadth fell between m1 and m2.

All four skulls were in rather poor condition, so the values are not included in any of the calculations for the remainder of the population. Their value is slight, at best, but they are included here in case further ones become available and can be used for reference.

MEAN CRANIOMETRIC VALUES

Sub-I skulls

TRAIT	NUMBER OF SKULLS	MEAN VALUE	RANGE
1. Cranial capacity	1	282.0	...
2. Orbital capacity	2	10.0	9-11
3. Maximum length	3	110.0	105-118
4. Cranial length	3	110.0	105-118
5. Inion-prosthion	3	125.0	117-133
6. Basion-prosthion	2	68.5	65-72
7. Basion-nasion	2	62.0	...
8. Maximum breadth to suture	3	89.0	86-93
9. Total maximum breadth	3	89.0	86-93
10. Postorbital breadth	4	67.5	63-72
11. Biorbital breadth	3	65.7	64-68
12. Interorbital breadth	4	9.2	8-11
13. Bizygomatic breadth	3	74.0	71-76
14. Total skull height	2	67.5	67-68
15. Cranial height	2	67.5	67-68
16. Facial height	4	46.0	39-51
17. Palate length	4	37.2	33-41
18. Palate breadth	4	38.0	33-42
19. Cranial index	3	81.0	78.8-82.2
20. Upper facial index	3	169.7	148.8-182.0
21. Palatal index	4	102.0	97.5-108.2

Mixed male and female, Stage I

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	10	432.0	...	...	...	330-510
2.	Orbital capacity	8	14.6	...	...	...	11-20
3.	* Maximum length	16	128.2	9.15	2.29	7.13	111-143
4.	* Cranial length	16	128.2	9.15	2.29	7.13	111-143
5.	* Inion-prosthion	16	156.2	14.20	3.55	9.10	136-183
6.	Basion-prosthion	12	91.8	...	...	...	76-113
7.	Basion-nasion	12	79.2	...	...	...	67-98
8.	Maximum breadth to suture	10	100.8	...	...	...	90-107
9.	Total maximum breadth	14	100.9	...	...	...	88-116
10.	* Postorbital breadth	16	68.9	9.13	2.28	13.25	61-74
11.	* Biorbital breadth	15	79.9	8.16	2.11	10.21	66-97
12.	* Interorbital breadth	16	11.4	1.69	0.42	14.82	9-15
13.	* Bizygomatic breadth	16	95.2	10.80	2.70	11.36	76-114
14.	Total skull height	10	85.9	...	...	...	76-95
15.	Cranial height	10	85.9	...	...	...	76-95
16.	* Facial height	16	62.7	7.63	1.91	12.19	49-79
17.	* Palate length	16	52.5	6.04	1.51	11.50	37-63
18.	* Palate breadth	16	48.1	2.46	0.62	5.13	43-55
19.	Cranial index	14	80.9	...	...	...	77.2-85.2
20.	* Upper facial index	16	152.1	6.42	1.60	4.21	143-161
21.	* Palatal index	16	95.9	8.21	2.05	8.57	85.8-118.9

Mean variability 9.55

* Twelve traits statistically analyzed in all age groups.

Male, Stage II

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	13	486.0	...	...	...	405-590
2.	Orbital capacity	15	23.3	3.28	0.82	14.05	17-28
3.	* Maximum length	22	143.1	6.98	1.49	4.87	133-160
4.	* Cranial length	22	143.1	6.98	1.49	4.87	133-160
5.	* Inion-prosthion	21	195.7	11.12	2.43	5.70	183-226
6.	Basion-prosthion	15	127.1	9.28	2.39	7.29	113-150
7.	Basion-nasion	15	97.5	6.25	1.61	6.41	89-114
8.	Maximum breadth to suture	22	103.3	8.38	1.78	8.10	97-110
9.	Total maximum breadth	21	118.2	6.75	1.47	5.70	111-132
10.	* Postorbital breadth	22	73.5	3.80	0.81	5.17	66-80
11.	* Biorbital breadth	22	101.8	5.85	1.38	5.75	92-115
12.	* Interorbital breadth	22	16.6	3.23	0.67	19.45	11-22
13.	* Bizygomatic breadth	21	120.6	6.40	1.40	5.31	111-134
14.	Total skull height	16	92.9	4.32	1.08	4.65	87-103
15.	Cranial height	16	92.9	4.32	1.08	4.65	87-103
16.	* Facial height	22	82.9	5.68	1.19	6.86	74-96
17.	* Palate length	22	71.0	6.28	1.34	8.85	62-89
18.	* Palate breadth	22	59.5	2.54	0.54	4.27	55-65
19.	Cranial index	21	81.9	3.49	0.76	4.27	76.7-88.8
20.	* Upper facial index	21	147.3	6.65	1.46	4.51	132.3-161.5
21.	* Palatal index	22	84.3	5.38	1.14	6.45	67.5-89.8

Mean variability 6.86

* Twelve trait mean variability 6.84

Male, Stage III

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	17	604.7	48.00	11.60	9.52	440-590
2.	Orbital capacity	13	26.7	...	...	...	20-38
3.	* Maximum length	19	152.7	7.22	1.66	4.73	142-160
4.	* Cranial length	19	147.0	7.83	1.80	5.32	135-163
5.	* Inion-prosthion	19	219.6	10.50	2.42	4.79	207-243
6.	Basion-prosthion	18	148.3	9.30	2.19	6.27	125-162
7.	Basion-nasion	18	106.0	4.17	0.98	3.93	99-114
8.	Maximum breadth to suture	19	103.0	4.70	1.08	4.56	96-112
9.	Total maximum breadth	19	128.6	6.30	1.44	4.90	118-144
10.	* Postorbital breadth	19	72.9	4.00	0.92	5.50	65-79
11.	* Biorbital breadth	19	111.0	6.29	1.45	5.66	100-126
12.	* Interorbital breadth	19	20.4	2.86	0.66	14.00	16-27
13.	* Bizygomatic breadth	19	134.6	8.12	1.85	6.03	123-156
14.	Total skull height	18	95.3	3.73	0.88	3.92	89-102
15.	Cranial height	18	95.3	3.73	0.88	3.92	89-102
16.	* Facial height	19	93.9	5.75	1.32	6.13	80-103
17.	* Palate length	19	84.0	5.70	1:31	6.79	70-91
18.	* Palate breadth	19	64.0	3.00	0.69	4.70	60-73
19.	Cranial index	19	84.4	2.43	0.56	2.88	80.1-89.6
20.	* Upper facial index	19	144.0	10.50	2.41	7.30	131.1-167.8
21.	* Palatal index	19	76.5	5.07	1.16	6.64	70.3-88.8

Mean variability 5.87

* Twelve trait mean variability 6.47

Male, Stage IV

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	25	523.0	51.30	10.26	9.81	410-635
2.	Orbital capacity	20	33.3	4.59	1.02	13.80	26-42
3.	* Maximum length	28	166.3	15.60	2.95	9.39	138-204
4.	* Cranial length	27	151.7	9.27	1.78	6.10	131-174
5.	* Inion-prosthion	29	248.0	21.30	3.96	8.60	223-300
6.	Basion-prosthion	25	172.9	12.80	2.56	7.32	150-196
7.	Basion-nasion	25	119.0	8.69	1.74	7.29	102-138
8.	Maximum breadth to suture	29	103.8	4.24	0.79	4.08	96-111
9.	Total maximum breadth	29	142.0	10.80	2.00	7.64	126-164
10.	* Postorbital breadth	29	72.1	3.70	0.69	5.14	64-86
11.	* Biorbital breadth	29	127.8	12.48	2.32	9.77	107-161
12.	* Interorbital breadth	29	25.2	5.12	0.95	20.23	16-36
13.	* Bizygomatic breadth	29	153.0	12.00	2.23	7.85	136-184
14.	Total skull height	25	99.0	8.95	1.79	9.04	87-129
15.	Cranial height	24	96.2	5.12	1.04	5.32	87-110
16.	* Facial height	29	106.8	8.90	1.66	8.35	92-126
17.	* Palate length	29	97.8	7.69	1.43	7.86	83-117
18.	* Palate breadth	26	70.2	4.48	0.83	6.52	63-81
19.	Cranial index	28	86.4	4.95	0.94	5.74	78.5-100.0
20.	* Upper facial index	29	143.9	9.90	1.83	6.88	129.2-169.5
21.	* Palatal index	29	72.0	3.82	0.71	5.32	64.1-81.2

Mean variability 8.19

* Twelve trait mean variability 8.50

Male, Stage V

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	38	540.0	63.20	10.20	11.68	425-660
2.	Orbital capacity	44	39.4	4.12	0.62	10.43	27-46
3.	* Maximum length	59	187.7	14.05	1.82	7.51	158-220
4.	* Cranial length	57	161.2	7.72	1.02	4.78	143-178
5.	* Inion-prosthion	59	280.3	19.50	2.51	6.96	240-322
6.	Basion-prosthion	48	191.7	10.40	1.51	5.43	169-212
7.	Basion-nasion	48	131.0	6.80	0.99	5.19	118-149
8.	Maximum breadth to suture	61	101.0	4.26	0.55	4.22	94-111
9.	Total maximum breadth	58	153.5	9.55	1.25	6.23	132-175
10.	* Postorbital breadth	62	72.3	3.56	0.40	4.94	67-79
11.	* Biorbital breadth	60	143.8	9.15	1.18	6.37	127-166
12.	* Interorbital breadth	62	30.4	4.58	0.58	15.10	22-41
13.	* Bizygomatic breadth	59	172.3	10.13	1.32	5.89	148-200
14.	Total skull height	47	114.9	12.90	1.88	11.22	94-148
15.	Cranial height	47	99.0	5.13	0.75	5.19	88-110
16.	* Facial height	62	117.3	8.75	1.11	7.45	98-141
17.	* Palate length	61	107.1	6.18	0.79	5.77	93-125
18.	* Palate breadth	60	75.4	4.54	0.58	6.03	65-85
19.	Cranial index	56	83.7	5.47	0.72	6.57	71.4-98.2
20.	* Upper facial index	59	147.3	10.89	1.40	7.39	130.2-187.5
21.	* Palatal index	59	70.8	3.92	0.51	5.54	61.6-89.7

Mean variability 7.14

* Twelve trait mean variability 6.98

Male, Stage VI

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	95	549.0	57.60	5.91	10.50	420-685
2.	Orbital capacity	136	41.2	4.54	0.39	11.00	30-54
3.	* Maximum length	148	195.7	7.95	0.65	4.07	171-228
4.	* Cranial length	140	163.4	7.25	0.61	4.43	143-183
5.	* Inion-prosthion	148	297.5	15.10	1,24	5.09	257-332
6.	Basion-prosthion	123	198.4	10.70	0.97	5.40	170-221
7.	Basion-nasion	124	134.0	6.40	0.58	4.78	121-153
8.	Maximum breadth to suture	145	101.8	4.64	0.39	4.55	84-117
9.	Total maximum breadth	141	160.0	9.18	0.77	5.75	140-182
10.	* Postorbital breadth	147	71.0	3.96	0.33	5.58	59-80
11.	* Biorbital breadth	147	150.0	6.50	0.54	4.33	131-168
12.	* Interorbital breadth	146	32.0	3.72	0.31	11.61	21-46
13.	* Bizygomatic breadth	136	178.8	7.53	0.64	4.21	162-198
14.	Total skull height	121	123.3	10.60	0.97	8.60	101-150
15.	Cranial height	121	99.3	5.24	0.48	5.28	86-116
16.	* Facial height	150	119.6	8.30	0.66	6.94	91-141
17.	* Palate length	143	111.2	6.85	0.57	6.15	94-126
18.	* Palate breadth	139	77.7	4.15	0.35	5.48	67-88
19.	Cranial index	139	80.6	5.48	0.47	6.80	69.3-94.5
20.	* Upper facial index	135	150.0	11.69	1.00	7.80	125.6-189.1
21.	* Palatal index	133	70.0	3.42	0.30	4.89	61.8-79.2

Mean variability 6.34

* Twelve trait mean variability 5.88

Upper M2	132	16.8	1.00	0.09	5.95	14-19
Lower M2	112	15.5	0.99	0.09	6.38	13-19
Upper canine	72	35.8	4.37	0.52	12.20	27-47
Lower canine	74	28.6	3.19	0.37	11.12	23-37

Female, Stage II

	TRAIT	NUMBER	MEAN	RANGE
1.	Cranial capacity	4	412.5	350-480
2.	Orbital capacity	5	19.8	15-23
3.	Maximum length	7	133.4	125-144
4.	Cranial length	7	133.4	125-144
5.	Inion-prosthion	6	177.2	166-186
6.	Basion-prosthion	5	113.2	106-119
7.	Basion-nasion	6	87.8	82-93
8.	Maximum breadth to suture	7	100.4	95-105
9.	Total maximum breadth	6	110.8	107-118
10.	Postorbital breadth	7	69.0	63-73
11.	Biorbital breadth	7	94.3	89-101
12.	Interorbital breadth	7	13.4	12-15
13.	Bizygomatic breadth	7	111.1	104-115
14.	Total skull height	7	86.7	80-95
15.	Cranial height	7	86.7	80-95
16.	Facial height	6	77.7	74-83
17.	Palate length	6	60.3	55-67
18.	Palate breadth	7	54.9	52-57
19.	Cranial index	6	82.7	78.4-87.3
20.	Upper facial index	6	142.6	136.2-150.9
21.	Palatal index	6	91.0	83.6-96.5

Female, Stage III

	TRAIT	NUMBER	MEAN	RANGE
1.	Cranial capacity	7	465.7	420-520
2.	Orbital capacity	6	25.0	22-31
3.	Maximum length	12	147.0	136-154
4.	Cranial length	12	141.7	130-154
5.	Inion-prosthion	12	206.7	195-228
6.	Basion-prosthion	7	139.0	130-145
7.	Basion-nasion	7	102.9	94-108
8.	Maximum breadth to suture	12	99.2	93-107
9.	Total maximum breadth	11	121.8	114-128
10.	Postorbital breadth	12	70.7	64-82
11.	Biorbital breadth	11	108.5	102-115
12.	Interorbital breadth	12	18.7	16-22
13.	Bizygomatic breadth	10	132.3	125-139
14.	Total skull height	7	93.7	89-99
15.	Cranial height	7	93.7	89-99
16.	Facial height	12	87.8	77-104
17.	Palate length	12	77.7	71-86
18.	Palate breadth	12	61.8	58-64
19.	Cranial index	11	82.9	79.6-85.7
20.	Upper facial index	10	150.3	133.5-171.5
21.	Palatal index	12	79.8	73.3-83.1

Female, Stage IV

	TRAIT	NUMBER	MEAN	RANGE
1.	Cranial capacity	9	457.2	410-545
2.	Orbital capacity	8	29.3	25-36
3.	Maximum length	11	152.5	131-163
4.	Cranial length	11	142.0	131-151
5.	Inion-prosthion	11	218.5	183-229
6.	Basion-prosthion	10	150.3	125-160
7.	Basion-nasion	9	108.8	104-116
8.	Maximum breadth to suture	11	98.3	87-108
9.	Total maximum breadth	11	127.2	111-140
10.	Postorbital breadth	11	70.5	63-75
11.	Biorbital breadth	11	117.2	101-125
12.	Interorbital breadth	10	22.6	19-26
13.	Bizygomatic breadth	11	137.5	121-149
14.	Total skull height	10	93.6	84-99
15.	Cranial height	10	93.6	84-99
16.	Facial height	10	94.9	89-101
17.	Palate length	11	84.4	67-90
18.	Palate breadth	11	65.1	61-68
19.	Cranial index	11	83.6	74.4-89.4
20.	Upper facial index	10	146.7	137.7-157.0
21.	Palatal index	11	77.6	69.0-91.1

Female, Stage V

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	22	470.4	57.70	12.30	12.26	390-575
2.	Orbital capacity	30	30.1	3.24	0.69	10.75	25-38
3.	* Maximum length	30	155.8	5.82	1.06	3.74	145-171
4.	* Cranial length	28	144.0	5.21	0.97	3.62	133-154
5.	* Inion-prosthion	30	227.2	6.34	1.15	2.79	212-240
6.	Basion-prosthion	22	158.3	5.92	1.26	3.74	145-168
7.	Basion-nasion	22	112.9	6.13	1.31	5.43	103-119
8.	Maximum breadth to suture	30	99.2	4.25	0.77	4.29	90-109
9.	Total maximum breadth	30	131.6	5.68	1.04	4.31	118-143
10.	* Postorbital breadth	31	69.8	3.80	0.68	5.45	63-78
11.	* Biorbital breadth	31	121.3	5.22	0.94	4.30	108-131
12.	* Interorbital breadth	31	23.2	3.52	0.63	15.18	16-28
13.	* Bizygomatic breadth	29	143.7	4.42	0.82	3.07	137-154
14.	Total skull height	22	95.6	4.86	1.03	5.08	84-106
15.	Cranial height	22	95.6	4.86	1.03	5.08	84-106
16.	* Facial height	31	99.0	5.30	0.95	5.36	88-113
17.	* Palate length	31	89.0	3.43	0.62	3.74	83-95
18.	* Palate breadth	30	66.8	3.66	0.67	5.48	59-73
19.	Cranial index	30	85.1	3.28	0.60	3.86	79.8-91.4
20.	* Upper facial index	29	146.8	8.95	1.66	6.10	127.0-166.0
21.	* Palatal index	30	75.2	3.19	0.58	4.25	67.8-82.5

Mean variability 5.61

* Twelve trait mean variability 5.26

Female, Stage VI

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	56	459.0	41.80	5.60	9.11	340-580
2.	Orbital capacity	82	31.8	3.90	0.43	12.26	25-45
3.	* Maximum length	87	156.8	7.51	0.80	4.80	140-178
4.	* Cranial length	86	145.9	6.18	0.67	4.24	131-162
5.	* Inion-prosthion	88	229.2	9.14	0.98	3.98	207-261
6.	Basion-prosthion	71	157.0	3.76	0.45	2.39	141-175
7.	Basion-nasion	71	112.4	4.52	0.54	4.02	104-125
8.	Maximum breadth to suture	87	98.8	6.04	0.65	6.11	87-106
9.	Total maximum breadth	89	130.9	6.30	0.67	4.81	115-147
10.	* Postorbital breadth	90	68.8	3.52	0.37	5.12	61-79
11.	* Biorbital breadth	87	122.6	5.35	0.57	4.36	109-136
12.	* Interorbital breadth	90	23.4	3.74	0.39	16.00	15-35
13.	* Bizygomatic breadth	84	146.2	6.58	0.72	4.50	132-160
14.	Total skull height	69	94.0	4.15	0.50	4.42	84-103
15.	Cranial height	68	93.9	4.57	0.55	4.88	83-110
16.	* Facial height	92	99.0	6.30	0.66	6.37	82-113
17.	* Palate length	89	90.0	4.96	0.53	5.52	78-104
18.	* Palate breadth	90	68.6	3.40	0.36	4.96	61-79
19.	Cranial index	86	83.9	4.27	0.46	5.10	73.6-95.1
20.	* Upper facial index	84	148.3	10.74	1.17	7.25	122.0-190.9
21.	* Palatal index	87	76.7	3.97	0.43	5.18	66.6-90.7

Mean variability 5.97

* Twelve trait mean variability 6.02

Upper M2	79	15.7	0.82	0.09	5.23	14-18
Lower M2	67	14.5	1.15	0.14	7.93	12-20
Upper canine	64	20.3	1.22	0.15	6.02	16-26
Lower canine	57	19.2	1.08	0.14	5.64	13-24

Male, Stage VI, B

TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1. Cranial capacity	55	560.8	54.80	7.40	9.78	440-685
2. Orbital capacity	70	41.0	4.00	0.62	9.76	34-50
3. * Maximum length	79	190.5	8.72	0.98	4.57	171-213
4. * Cranial length	76	162.0	7.60	0.87	4.70	143-181
5. * Inion-prosthion	79	294.0	13.20	1.50	4.60	257-319
6. Basion-prosthion	66	201.4	9.86	1.21	4.91	179-221
7. Basion-nasion	66	134.4	6.13	0.76	4.56	122-150
8. Maximum breadth to suture	79	103.4	4.49	0.50	4.33	90-117
9. Total maximum breadth	79	163.6	8.60	0.97	5.27	141-182
10. * Postorbital breadth	78	71.6	3.72	0.42	5.20	65-80
11. * Biorbital breadth	79	146.3	6.20	0.83	4.23	131-168
12. * Interorbital breadth	77	32.6	3.99	0.46	12.22	21-46
13. * Bizygomatic breadth	71	180.5	7.44	0.88	4.12	164-198
14. Total skull height	66	123.3	9.80	1.20	7.90	101-140
15. Cranial height	66	100.7	4.74	0.58	4.70	86-110
16. * Facial height	78	120.4	8.88	1.01	7.38	91-141
17. * Palate length	73	111.6	6.60	0.77	5.91	95-125
18. * Palate breadth	74	77.6	4.00	0.46	5.16	68-87
19. Cranial index	79	86.0	3.60	0.40	4.20	80.0-94.5
20. * Upper facial index	70	151.4	12.31	1.47	8.15	125.6-189.1
21. * Palatal index	70	69.8	3.52	0.42	5.05	61.8-79.2

Mean variability 6.03

* Twelve trait mean variability 6.10

Male, Stage VI, L

	TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1.	Cranial capacity	36	533.0	62.50	10.40	11.80	420-680
2.	Orbital capacity	49	40.6	4.33	0.62	10.70	30-54
3.	* Maximum length	56	204.4	11.20	1.50	5.48	181-228
4.	* Cranial length	51	166.6	7.00	0.98	4.20	153-183
5.	* Inion-prosthion	55	307.3	15.20	2.00	4.95	270-332
6.	Basion-prosthion	45	197.5	11.54	1.74	5.85	170-217
7.	Basion-nasion	45	134.6	7.27	1.08	5.40	121-153
8.	Maximum breadth to suture	55	101.2	4.40	0.59	4.35	84-110
9.	Total maximum breadth	56	156.4	8.60	1.10	5.50	140-177
10.	* Postorbital breadth	56	69.6	4.21	0.56	6.05	59-76
11.	* Biorbital breadth	56	151.1	6.90	0.92	4.57	135-166
12.	* Interorbital breadth	56	32.5	3.85	0.51	11.82	24-41
13.	* Bizygomatic breadth	55	177.9	7.47	1.01	4.20	162-196
14.	Total skull height	43	127.8	11.40	1.80	8.90	104-150
15.	Cranial height	43	100.2	5.68	0.87	5.68	86-116
16.	* Facial height	56	120.6	8.25	1.10	6.85	100-140
17.	* Palate length	55	112.1	8.00	1.08	7.14	94-126
18.	* Palate breadth	54	78.2	4.40	0.60	5.64	67-88
19.	Cranial index	56	76.1	2.50	0.33	3.30	69.3-79.9
20.	* Upper facial index	55	148.7	11.25	1.65	7.59	126.3-181.0
21.	* Palatal index	53	70.5	3.50	0.48	4.98	64.1-78.5

Mean variability 6.43

* Twelve trait mean variability 6.12

Comparison of Male, Stage VI B and L

	TRAIT	B MEAN	L MEAN	DIFF.	S. E. DIFF.	*t*	χ^2
1.	Cranial capacity	560.8	533.0	27.8	12.80	2.20	
2.	Orbital capacity	41.0	40.6	0.4	0.88	0.45*	
3.	Maximum length	190.5	204.4	13.9	1.79	7.80	
4.	Cranial length	162.0	166.6	4.6	1.30	3.50	
5.	Inion-prosthion	294.0	207.3	13.3	2.54	5.20	
6.	Basion-prosthion	201.4	197.5	3.9	2.12	1.84*	6.8% level
7.	Basion-nasion	134.4	134.6	0.2	1.32	0.15*	
8.	Maximum breadth to suture	103.4	101.2	2.2	0.78	2.80	
9.	Total maximum breadth	163.6	156.4	7.2	1.50	4.80	
10.	Postorbital breadth	71.6	69.6	2.0	0.70	2.80	
11.	Biorbital breadth	146.3	151.1	4.8	1.20	4.00	
12.	Interorbital breadth	32.6	32.5	0.1	0.69	0.14*	
13.	Bizygomatic breadth	180.5	177.9	2.6	1.34	1.94*	5.24% level
14.	Total skull height	123.3	127.8	4.5	2.10	2.10	
15.	Cranial height	100.7	100.2	0.5	1.04	0.48*	
16.	Facial height	120.4	120.6	0.2	1.49	0.13*	
17.	Palate length	111.6	112.1	0.5	1.33	0.38*	
18.	Palate breadth	77.6	78.2	0.6	0.76	0.80*	
19.	Cranial index	86.0	76.1	9.9	0.52	19.00	
20.	Upper facial index	151.4	148.7	2.7	2.21	1.20*	
21.	Palatal index	69.8	70.5	0.7	0.64	1.10*	

* Not statistically significant.

Comparison of Male, Stage VI B and L
Morphological traits
Teeth Dimensions

	B (Per cent)				L (Per cent)				χ^2
Cranio-pharyngeal canal									
0	45.5				43.4				
+	46.8				51.0				Not significant
++	7.7				5.6				
Teeth: Wear									
0	1.3				0.0				
+	24.4				50.0)				1% level
++	52.6				39.0)				
Extreme	21.8				10.7)				Not significant
Bite									
Under	1.7				0.0				
Edge	76.2				91.4				
Over	22.1				8.6				10% level
Loss									
Some	25.5				22.0				
None	74.5				78.0				Not significant
Alveolar abscess									
Some	44.1				26.8				Just over 5% level
None	55.9				73.2				
Infra-orbital canal									
Unilateral	20.3				23.2				
Left and right single	31.7				32.2				Not significant
Double	48.1				44.6				
			σ	σ_m			σ	σ_m	
Breadth of M2 Upper	16.7	(68)	1.02	.124	16.9	(49)	.98	.140)	
Lower	15.6	(58)	1.04	.137	15.6	(43)	.91	.139)	Not significant
Length of canines Upper	35.5	(37)	3.86	.635	34.8	(25)	4.10	.823)	
Lower	31.8	(40)	3.57	.565	31.3	(26)	3.06	.577)	Not significant

Breadth of molar	diff.	0.20	Lower molar	diff.	0
	σ diff.	0.186		σ diff.	0
	t	1.07		t	0
Length of canine	diff.	0.70	Lower canine	diff.	0.50
	σ diff.	1.04		σ diff.	0.80
	t	0.67		t	0.63

Female, Stage VI B

TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1. Cranial capacity	30	469.3	37.10	6.75	7.92	395-520
2. Orbital capacity	37	31.4	3.85	0.62	12.26	25-45
3. * Maximum length	40	154.2	5.80	0.92	3.76	140-165
4. * Cranial length	38	144.3	4.84	0.78	3.35	134-153
5. * Inion-prosthion	39	229.0	7.52	1.20	3.28	215-250
6. Basion-prosthion	31	160.3	5.80	1.04	3.61	146-172
7. Basion-nasion	31	113.3	4.23	0.76	3.73	105-122
8. Maximum breadth to suture	39	99.9	3.15	0.50	3.14	92-106
9. Total maximum breadth	39	135.4	4.22	0.67	3.12	126-147
10. * Postorbital breadth	39	69.7	3.62	0.58	5.20	61-79
11. * Biorbital breadth	38	123.4	5.02	0.82	4.06	112-131
12. * Interorbital breadth	39	24.9	3.28	0.53	13.16	17-35
13. * Bizygomatic breadth	38	149.4	4.74	0.77	3.17	132-156
14. Total skull height	29	94.8	3.71	0.69	3.92	88-102
15. Cranial height	29	95.1	4.03	0.75	4.24	86-102
16. * Facial height	39	100.5	5.82	0.94	5.82	82-109
17. * Palate length	39	91.0	4.55	0.72	5.00	83-102
18. * Palate breadth	39	70.3	2.94	0.47	4.18	64-79
19. Cranial index	39	87.9	2.29	0.37	2.61	85.0-95.1
20. * Upper facial index	38	148.8	9.83	1.59	6.61	130.1-186.9
21. * Palatal index	39	76.6	3.33	0.53	4.35	66.6-84.8

Mean variability 5.07

* Twelve trait mean variability 5.16

Female, Stage VI L

TRAIT	NUMBER	MEAN	S. D.	S. E.	C. V.	RANGE
1. Cranial capacity	24	455.4	51.30	10.50	11.22	340-580
2. Orbital capacity	38	33.4	2.90	0.47	8.79	27-39
3. * Maximum length	44	160.2	7.80	1.30	4.87	144-178
4. * Cranial length	44	147.6	7.08	1.07	4.80	131-162
5. * Inion-prosthion	45	230.3	10.95	1.65	4.75	207-261
6. Basion-prosthion	35	157.8	8.65	1.46	5.50	141-175
7. Basion-nasion	35	112.8	4.32	0.73	3.92	104-125
8. Maximum breadth to suture	44	97.6	3.94	0.60	4.03	87-106
9. Total maximum breadth	45	128.6	5.95	0.89	4.62	115-139
10. * Postorbital breadth	44	68.7	3.46	0.53	5.18	61-74
11. * Biorbital breadth	43	122.8	6.06	0.92	4.95	109-136
12. * Interorbital breadth	44	23.2	3.44	0.51	14.82	15-30
13. * Bizygomatic breadth	42	144.9	6.48	1.00	4.48	133-160
14. Total skull height	34	93.6	4.13	0.70	4.41	84-103
15. Cranial height	34	93.1	3.89	0.68	4.28	84-103
16. * Facial height	46	98.9	6.71	0.99	6.80	84-113
17. * Palate length	44	89.9	5.46	0.81	6.15	78-104
18. * Palate breadth	44	68.5	3.60	0.54	5.25	61-77
19. Cranial index	41	80.1	2.13	0.33	2.66	73.6-83.0
20. * Upper facial index	43	148.0	11.10	1.70	7.51	122.0-190.9
21. * Palatal index	44	76.6	4.42	0.67	5.77	69.3-90.7

Mean variability 5.94

* Twelve trait mean variability 6.28

Comparison of Female, Stage VI B and L

	TRAIT	B MEAN	L MEAN	DIFF.	S. E. DIFF.	t	χ^2
1.	Cranial capacity	469.3	455.4	13.9	12.50	1.12*	
2.	Orbital capacity	31.4	33.4	2.0	0.78	2.56	
3.	Maximum length	154.2	160.2	6.0	1.60	3.75	
4.	Cranial length	144.3	147.6	3.3	1.34	2.46	
5.	Inion-prosthion	229.0	230.3	1.3	2.02	0.64*	
6.	Basion-prosthion	160.3	157.8	2.5	1.80	1.40*	
7.	Basion-nasion	113.3	112.8	0.5	1.05	0.48*	
8.	Maximum breadth to suture	99.9	97.6	2.3	0.78	2.95	
9.	Total maximum breadth	135.4	128.6	6.8	1.11	6.12	
10.	Postorbital breadth	69.7	68.7	1.0	0.80	1.25	
11.	Biorbital breadth	123.4	122.8	0.6	1.23	0.49*	
12.	Interorbital breadth	24.9	23.2	1.7	0.74	2.30	
13.	Bizygomatic breadth	149.4	144.9	4.5	1.26	3.57	
14.	Total skull height	94.8	93.6	1.2	1.00	1.20*	
15.	Cranial height	95.1	93.1	2.0	1.01	1.98*	4.78% level
16.	Facial height	100.5	98.9	1.6	1.36	1.18*	
17.	Palate length	91.0	89.9	1.1	1.09	1.00*	
18.	Palate breadth	70.3	68.5	1.8	0.72	2.50	
19.	Cranial index	87.9	80.1	7.8	0.50	15.60	
20.	Upper facial index	148.8	148.0	0.8	2.33	0.34	
21.	Palatal index	76.6	76.6	0	0	0*	

* Not statistically significant.

Comparison of female, Stage VI B and L
Morphological traits
Teeth Dimensions

		B (Per cent)				L (Per cent)				χ^2
Cranio-pharyngeal canal										
	o	69.5				55.5				.....
	+	27.8				42.4				
	++	2.7				2.3				
Teeth: Wear	o	0.0				0.0				
	+	35.9				32.5				
	++	48.8				51.2				.....
	Extreme	15.3				16.3				
Bite										
	Under	3.1				0.0				
	Edge	81.3				89.2				.....
	Over	15.6				10.8				
*Loss										
	Some	3.0				19.9				Below 5% level
	None	97.0				80.1				
Alveolar abscess										
	Some	15.0				22.4				.....
	None	85.0				77.6				
Infra-orbital canal										
	Unilateral	20.5				15.2)				
*Left and Right	Single	20.5				43.5)				10% level
	Double	59.0				41.3)				Below 5%
*Breadth of M2				σ	σ_m			σ	σ_m	
	Upper	15.9	(35)	.749	.126	15.4	(38)	.860	.129	
	Lower	14.8	(29)	.850	.157	14.2	(34)	.750	.129	
Length of canines										
	Upper	20.3	(27)			20.1	(31)			.....
	Lower	19.2	(25)			19.1	(31)			
Breadth of M2	diff.	0.50				Lower molar	diff.	0.60		
	σ diff.	0.18					σ diff.	0.20		
	t	2.78					t	3.00		

* Not statistically significant.

(To Be Concluded)

RECENT LITERATURE

USE IN THE STUDY OF HUMAN BIOLOGY

In this department will be noticed the books and reprints which are currently received at the Editorial Office. Publications intended for notice here should be addressed to Dr. Lowell J. Reed, Editor of HUMAN BIOLOGY, 615 North Wolfe Street, Baltimore—5, Maryland, U. S. A.

I. EVOLUTION AND GENETICS

1. *Evolution — General Principles*

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2. *Human Evolution*

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5. *Human Heredity*

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3. *Migration*

[Vacant]

4. *Population*

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1. Proportion of nonwhite persons in the total population; United States (preliminary): 1940. Feb. 22, 1941. Pp. 3.

2. Figures on the employment status of nonwhite and white persons 14 years of age and over (preliminary): Mar. 24-30, 1940. Mar. 8, 1941. Pp. 7.

3. Nonwhite farm operators. May 16, 1941. Pp. 5.

4. Nonwhite farm operators, land in farms, and value of land and buildings: 1940 and 1930. Feb. 18, 1942. Pp. 9.

5. Nonwhite farm operators by race, for regions, divisions, and states: 1940. Mar. 16, 1942. Pp. 3.

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9. Negro population of voting age in the United States, by regions and states: 1940 and 1930. June 25, 1943. Pp. 4.

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